Skill Development and Training On the Use of Logging Residues and Discarded Oil Palm Trunk as Raw Material for the Downstream Wood Processing Sector

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ABSTRACT

In Ghana, majority of the rural folk depend on chain sawing activities for livelihood. Chain sawing is, however, characterized by degradation of the forest and therefore the government has put a ban on the production of lumber through chain sawing. This action has really affected the livelihood of people living along the fringes of the forest since they depend mostly on chain sawing activities to take care of their families. The ban on chain sawing activities by the government has led to migration of some of the youth from the rural areas to the urban areas to search for jobs which do not exist. Some of the youth get frustrated because of the lack of jobs in the urban areas and resort to some form of social vices. The youth in the rural areas could be gainfully employed if they are assisted to convert into lumber, and in an efficient manner, the large volumes of logging residues that are left in the forest in the form of branches, buttresses and stumps.

Another area that is worth mentioning and needs to be addressed urgently to help halt the degradation of the forest is the large volume of oil palm trunks that are left in the forest to rot after tapping the wine in the trees. Thus, enormous quantities of palm trees are discarded in vain, while destruction of the rain forest has been expanding in the same tropical areas by excess cutting of trees. People living along the fringes of the forest could also be gainfully employed if they are assisted to convert the oil palm trunks into lumber using appropriate processing technology. Skill development and training on the use of logging residues and discarded oil palm trunk as raw material for the downstream wood processing sector is a promising venture to promote Technical and Vocational Education and Training

1. INTRODUCTION

In its quest to arrest the degradation of the tropical rain forest, appropriate agencies or institutions responsible for forestry and forest products research are looking for alternative raw materials for the timber industry as substitute for the traditional timber species which are fast dwindling (Okai 2001, Okai et al. 2004, Okai et al. 2005, Okai and Boateng 2006). Some species whose machining properties are not well known and which have the potential of being utilized by the timber industry include the oil palm tree which is a non-timber forest product and commonly referred to as the tree of life because of its numerous applications in daily life. The oil palm tree which is a native species to West Africa where it grows in abundance has been introduced to various parts of the tropics including Central Africa, East Africa, South America, and some parts of Asia, notably, Malaysia and Indonesia. Products that can be obtained from the oil palm tree include broom for sweeping, palm oil from its fruit, and mush room. Palm wine, a delicacy drink for the people in Sub-Sahara Africa is also tapped from the palm tree.

In spite of the numerous uses of the palm tree, its trunks are sometimes burnt or left to rot in the forest after tapping the wine without any utilization thereafter. Besides, the matured or over grown palm trees which are 25 to 30 years old are normally felled and replanting undertaken on the plots. Unfortunately, the felled palm trees are sometimes burnt to pave way for replanting and mixed farming after extracting the wine. Thus, enormous quantities of palm trees are discarded in vain, while destruction of the rain forest has been expanding in the same tropical areas by excess cutting of trees. The ban on chain sawing activities by the government has led to migration of some of the youth from the rural areas to the urban areas to search for jobs which do not exist. Some of the youth get frustrated because of the lack of jobs in the urban areas and resort to some form of social vices. The youth in the rural areas could be gainfully

employed if they are assisted to convert into lumber, and in an efficient manner, the large volumes of logging residues that are left in the forest in the form of branches, buttresses and stumps. The purpose of this study was to develop skills in the youth on the conversion of discarded oil palm trunk into useful products. It is expected that once the youth acquire the requisite skills in wood processing it will go a long way to reduce the rural-urban migration.

2. MATERIALS AND METHODS

2.1 Conversion of oil palm trunk into wood

Oil palm trunks of moisture content greater than 100% were sawn in the forest into boards of thickness 50mm and lengths 1.8m and 2.4m using a chainsaw machine. The sawn boards were immediately transported to the workshop of the Department of Design and Technology Education of the University of Education, Winneba for further processing. In order to ensure that boards from the oil palm tree were free from insects attack, they were immersed into a preservative for three (3) days. The preservative is made up of 2 litres of Dursban 4E and 504 litres of water. The preservative treated boards were kiln dried to moisture content between 8-10%.

2.2 Mechanical properties of oil palm wood

Compression parallel to grain tests and static bending tests, namely modulus of rupture (MOR) and modulus of elasticity (MOE) were conducted using the Instron strength testing machine (Model 4482). Thirty (30) wood samples each for compression parallel to grain tests and static bending tests were prepared in conformity to British Standard Institution (BS 373:1957) of testing small clear specimen. The straining rates or the cross head speed for static bending and compression parallel to grain tests at full scale load range of 100 KN were 2.54 mm/min and 0.6350 mm/min respectively. The following readings were recorded: displacement at maximum load, load at maximum load, stress at maximum load, and strain at maximum load in units of mm, KN, MPa, and mm/min, respectively. After each test, the tested samples were immediately kept in a polythene bag to prevent moisture content changes. Small portions of the oil palm wood samples near the portion of rupture under static bending and kept in the polythene bag were used to determine the moisture content. In the case of compression parallel to the grain, the moisture was determined from the entire wood sample. The moisture content of each wood sample of a particular test was measured using the standard method for measuring moisture content of wood samples (Okai et al. 2003). Thereafter, standard equations were used to convert the strength values at the measured moisture content to 12% moisture content.

2.3 Re-sawing of oil palm wood into boards

The kiln dried oil palm woods were re-sawn into specific dimension using an electric powered horizontal mobile bandmill (model LT 25) (Fig 3). The saw blade has a thickness of 0.8mm and width of 31.25mm.

2.4 Surface and thickness planning of boards from oil palm wood

Wood samples of oil palm wood dried to a moisture content of 10% were planned to nominal sizes on a thickness surface planer having four blades or knifes and operating at a spindle speed of 9000 revolution per minute (rpm).

2.5 Sanding of boards from oil palm wood

A drum sander (model 3000) was used to perform the sanding operation (Fig 5). It has an adjustable table to pick any thickness of wood samples and sand to predetermined thickness. Abrasives used were 60 and 80 grit for initial sanding and 20 grit abrasive for light sanding or finishing. The disc orbital sander (Fig. 1) was used for smooth sanding of the members and the removal of the raised edges after using a drum sander. The grit of the abrasive used for the orbit sanding was 180.

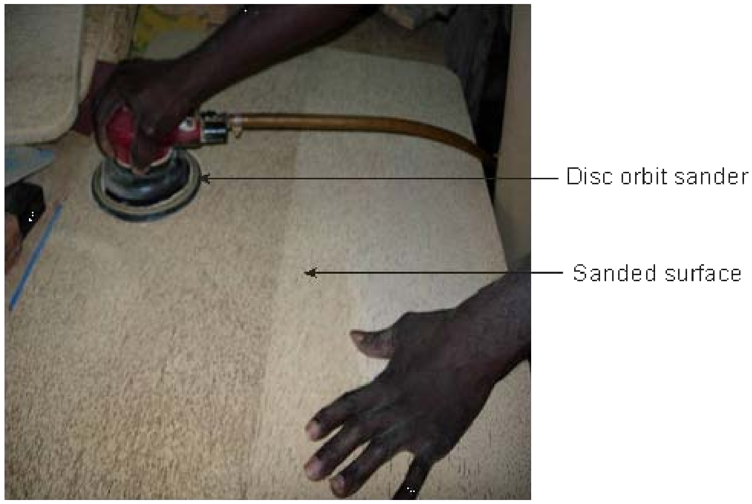

Fig 1. Orbital sanding of oil palm lumber

2.6 Turned flower pot and coffee table leg

Wood samples were laminated and pressed for 45minutes using polyvinyl acetate of hardare 3346 at a pressure of 450001b/in^2. It was planed to a dimension of 100mm × 100mm × 300mm and lathed to a flower pot. Sanding operation took place in the lathe as the flower pot revolves using sand paper of grit 60 for initial sanding and grit 120 and 180. A 100mm square × 300mm length scantling of the oil palm was turned for coffee table leg. A heavy floor standing lathe was used to lathe the sample. This lathe uses a belt drive to transmit power from (1hp) electric motor to the headstock spindle. It has a maximum speed of 2000rpm which is varied with the aid of stepped pulleys.

2.7 Preparation of template and members for furniture production

A compressed paper board was used to cut the template which was used to cut the individual parts of the members to their respective sizes. The artifact prepared were coffee table, centre table and a bed. The cutting lists are show below in Tables 1a to 1d. The template was used to cut the members to their specific sizes and shape using a band saw. Having sawn the various parts to size, the spindle moulder was used to machine the curved areas. Cutting across the grains of the oil palm wood was done with the radial-arm saw. It is fitted with an induction motor rated at 1.1KW. This is powerful enough to generate adequate saw-blade speeds of nearly 3000 rpm. The diameter of the blade used was 75mm and the thickness of the saw was 3mm.

2.8 Assembling members

2.8.1 Coffee table and center table

Widening joint was used to join member of dimensions 300mm x 300mm x 20mm to obtain a wider board for centre table and coffee table tops. The bases of these tables were also joined. Dowels prepared were used with polyvinyl acetate 3346 with Hardener of 3336 Hardare. Framing joints used were all dowelled. Drilling bit of diameter 10mm to the depth of 40mm was used. The joints were pressed very hard for 45 minutes at a pressure of 450001b/in^2. Individual parts, the legs, bases and the tops were cramped with their dowels using glue-polyvinyl acetate with a hardener Hardare 3336 at a pressure of 4500 1b/in^2.

Table 1a Cutting list for center table

Part #	Description	Quantity	Nominal Dimension (mm)	Actual dimension (mm)	Material
1	Top	1	900×700×25	850×650×20	Oil Palm Wood
2	Legs	4	500×80×25	450×75×20	Oil Palm Wood
3	Bottom/Base	1	450×450×25	400×400×20	Oil Palm Wood

Table 1b Cutting list for coffee table

Part #	Description	Quantity	Nominal Dimension (mm)	Actual dimension (mm)	Material
1	Top	1	450×450×25	400×400×20	Oil Palm Wood
2	Legs	1	500×80×25	450×75×20	Oil Palm Wood
3	Bottom/Base	1	350×350×25	290×290×20	Oil Palm Wood

Table 1c Cutting list for bed

Part #	Description	Quantity	Nominal Dimension (mm)	Actual dimension (mm)	Material
1	Head	1	1500×600×40	1440×500×30	Oil Palm Wood
2	Tail	1	1500×500×40	1440×400×30	Oil Palm Wood
3	Sides	2	2000×260×40	1920×240×30	Oil Palm Wood

Table 1d Cutting list for bed side cabinet

Part #	Description	Quantity	Nominal Dimension (mm)	Actual dimension (mm)	Material
1	Side	2	550×300×30	550×250×20	Oil Palm Wood
2	Top	1	400×300×30	350×250×20	Oil Palm Wood
3	Bottom	1	400×300×30	350×250×20	Oil Palm Wood
4	Shelve	2	350×300×30	310×250×20	Oil Palm Wood
5	Door	1	350×500×30	310×400×20	Oil Palm Wood

2.8.2 Bed

The widening joint used was grooved and tongue. Angle joint used was mortise and tenon. The design bed went through the above discussed processes. However the rest for the foam is not dependent on the side members of the bed. The strength of *Elaeis guineensis* (oil palm wood) is not as great as other wood species to withstand heavy load. Thus the bed designed is such that the weight of the user and the foam mattress will not have any effect on the side rail of the bed. A table was designed as a rest for the foam mattress.

3. RESULTS AND DISCUSSION

3.1 Sawing of oil palm trunk into wood

It was extremely difficult to convert oil palm trunk into lumber using the chainsaw machine. Additionally, it was difficult to re-saw boards of oil palm wood into smaller dimensions using the horizontal mobile bandmill known as the "woodmizer". The conversion process was characterized by frequent wearing or dulling of the saw teeth which had no tippings. The saw blades have to be sharpened or replaced less than ten minutes during operation.

3.2 Mechanical properties of oil palm wood

Table 2 shows the compression parallel to grain (13 N/mm^2), modulus of elasticity (2924 N/mm^2), and modulus of rupture (25 N/mm^2) of oil palm wood at 12% moisture content. The strength of a species can be assessed by various criteria including stiffness, compression parallel to grain, resistance to impact and bending strength. A species can be described as having a lower strength if its modulus of elasticity is less than 9000 N/mm^2. It is obvious from Table 2 that wood samples of the oil palm has a lower strength because, it has a modulus of elasticity of 2924 N/mm^2 which is much smaller than 9000 N/mm^2 which is the recommended modulus of elasticity below which a specie is said to have a lower modulus of elasticity.

Table 2. Mechanical properties of oil palm wood at 12% moisture content

MOR (N/mm^2)	MOE (N/mm^2)	Compression parallel to grain (N/mm^2)
25	2924	13
(9)	(887)	(1.5)

Note: Values in bracket are standard deviation

The use of a species depends to a large extent on its strength properties. The low strength properties of the oil palm wood clearly suggest that it may not have a wide range of application in daily life. For example, oil palm cannot be used for construction work which requires heavy load resistance such as bridges, window frames and door frames. In furniture work which sometimes require less load resistance, the oil palm may be suitable. Artifacts suitable for manufacturing from oil palm may include: flooring, flower pot, coffee table, center table, bed side cabinet, ceiling, wardrobe etc. Beds can also be manufactured from oil palm wood provided the entire weight of the individual sleeping on the bed is not exerted on the side rail but rather on a different support mechanisms

3.3 Surface and thickness planning of boards from oil palm wood

It was realized that contrary to expectation, the four knifes surface planer or four cutters surface planer revolving at a speed of 9000 rpm which was used for the planning operation produced rough surfaces with raised grains sharp in nature. The sharp raised grains have piercing effect on the fingers if care was not taken in handling the planed surfaces. Thus unlike species such as *milicia excelsa* and *khaya ivorensis* which may not require sanding operation because a planning operation may produce smooth surfaces, under no circumstances will a planning operation produce smooth surfaces when machining *Elaeis guineensis*.

3.4 Sanding of operations

The sanding operation using the drum sander was difficult because the sanding belt worn out or got torn within two or three cycles of operation. High friction was generated as the raised grains were grounded by the drum sanding causing burns on the surfaces of the wood samples. The fibres were raised and were sharp enough to wear out the sharpness of the grit. The disc orbit sanding operation was performed after drum sanding in order to ensure that all raised grains that could not be eliminated during the drum sanding operations were successfully removed.

3.5 Flow chart for the manufacturing of palm products from oil palm trunk

Figure 2 shows the flow chart for the manufacturing of palm products from oil palm trunk. It summarizes the manufacturing processes for converting the trunk of oil palm tree into useful products up to the assemble stage in sequential order. The order of operation consists of the conversion of the trunk of the oil palm tree into wood, preservative treatment of the boards, and kiln drying of the boards to 12% moisture content.

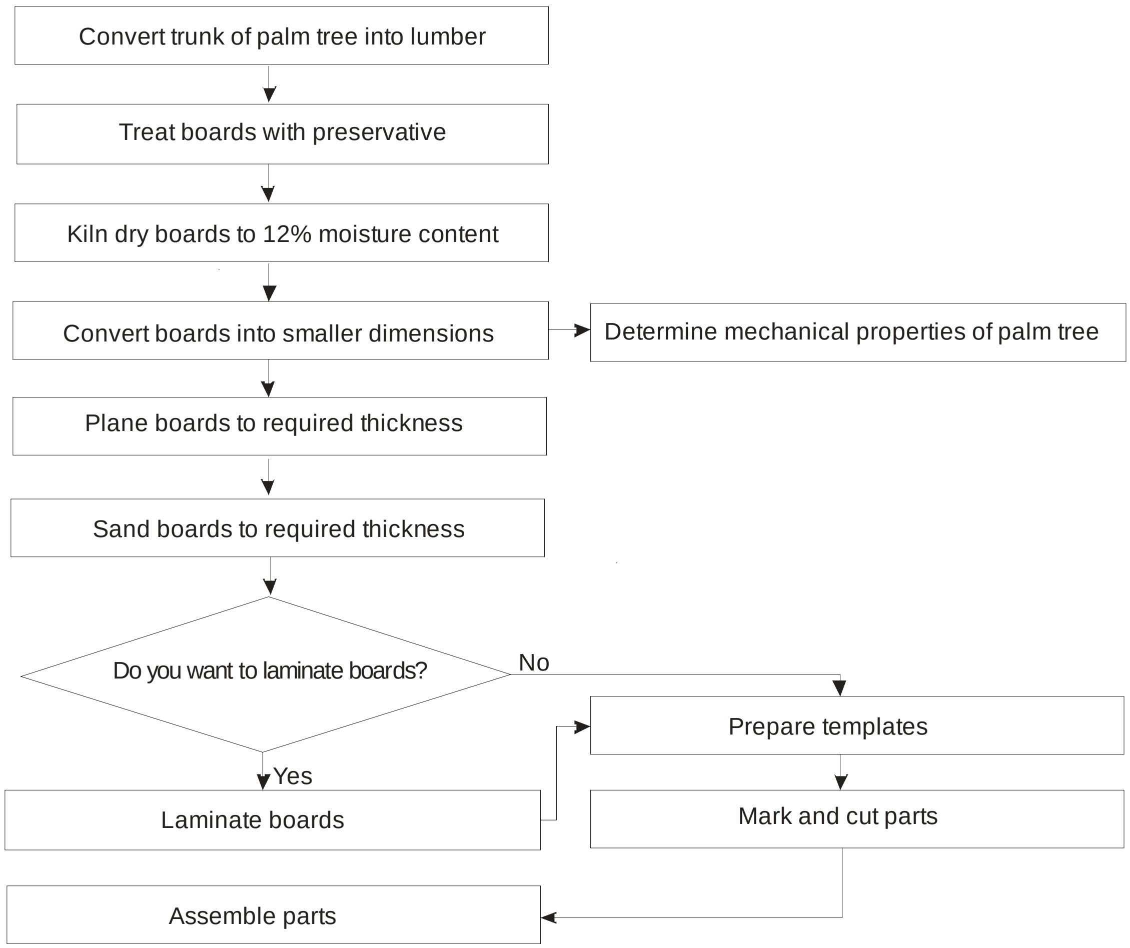

Fig 2. Flow chart for the manufacturing of palm products from oil palm trunk

3.6 Finishing of artifacts

It was observed from this study that after sanding wood samples of the oil palm with the disc orbital sander with abrasive grit of 180 the surface of the artifact was not smooth to handle. The grains were raised and very sharp thereby have the tendency to pierce into the bare hands if care was not taken in handling the artifact. The surface of the artifact was coated with sanding sealer with the objective of sealing all the pores on the artifact. After coating with the sanding sealer for 4 hours under normal room temperature, the artifact was sanded with emery cloth abrasive of grit 220. The emery cloth abrasive is usually used for finishing metal artifact but because of the piercing effect of the grains of the wooden artifact it was employed for sanding the wooden artifact. It was observed that all the raised grains which were piercing disappeared after sanding with either the emery cloth abrasive or wooden abrasive of grit 220.

The next phase of the finishing was to apply Synthetic Polyvinyl Lacquer (SPL). Unlike species such as Odum (*Milicia excelsa*), Mahogany (*Khaya ivorensis*) and Asanfena (*Aningeria robusta*) which take SPL

easily for final finishing, the oil palm wood absorbed the SPL very fast regardless of the application of sanding sealer to seal the pores on the surface of the artifact. Thus it appeared that the surface of the oil palm wood had not been polished and the surface looked very dull. However a new technique was developed. The surface of the artifact was sanded to remove the SPL using the emery cloth abrasive of grit 220. Synthetic clear Wood vanish which is less expensive as compared to the SPL lacquer was used to coat the surface of the artifact using hand brush in the direction of the grains and allowed to dry for 12 hours. The surface of the artifact was brighter than it used to be when the SPL lacquer was first applied. After the first layer of Vanish was applied by the hand brush, the artifact were sanded again using the emery cloth abrasive of grit 220. Thereafter, Synthetic clear Vanish was applied for the second time on the surface of the artifact. A very bright surface with a protective plastic-like film was observed on the surface. Figure 3 shows the flow chart for the finishing of palm products from the assemble stage to the final stage of product development.

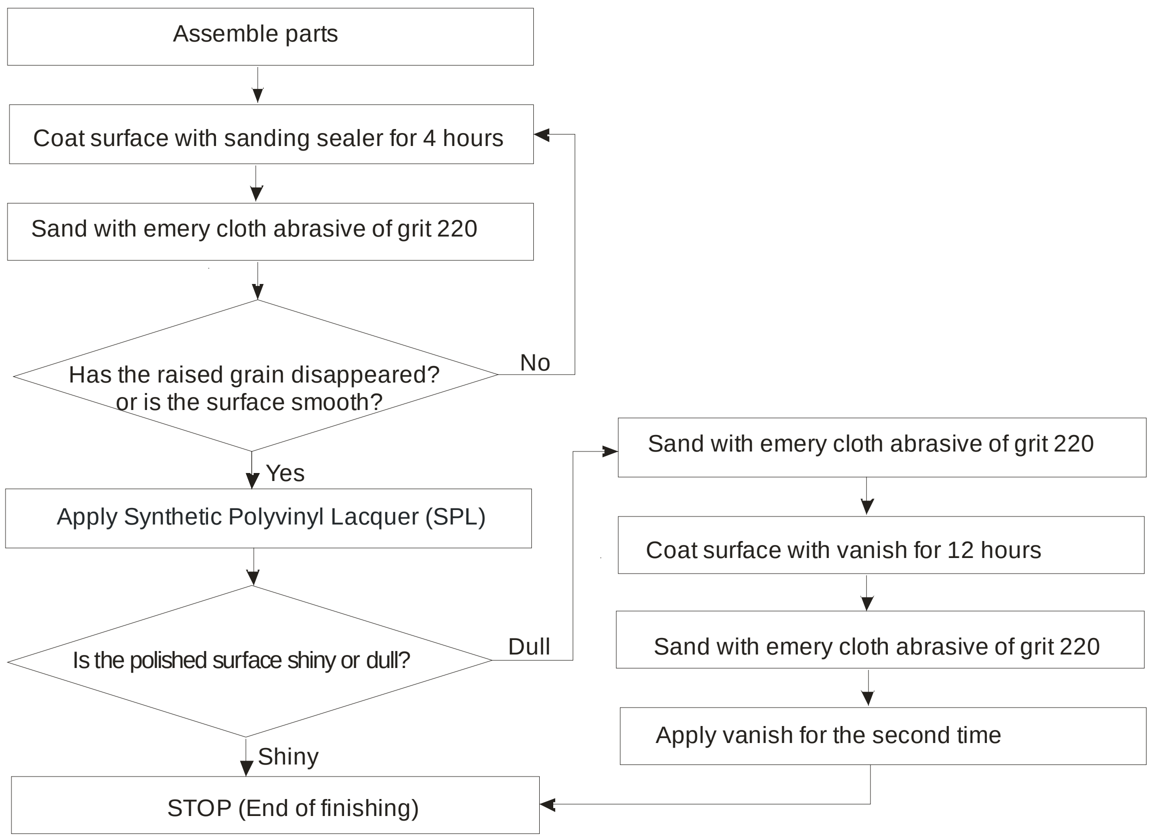

Fig 3 Flow chart for the finishing of palm products from the assemble stage

3.7 Products developed from oil palm wood

Figure 4 shows photographs of flower pot, coffee table, center table and bed produced from oil palm wood. The oil palm wood has a smaller strength compared to conventional wood. Therefore, in an attempt to produce a bed from oil palm wood, care was taken to ensure that the support for the foam/mattress rest on the floor instead of resting on the side rail. Any force exerted on the support for the foam/mattress is transmitted to the floor instead of being transmitted to the side rail. It is expected that in the design of wood products using oil palm wood, manufacturers will take into consideration the maximum force acting on the members in order to prevent failure of the members due to excessive load.

Fig. 4 Photograph of center table, flower pot, bedside cabinet coffee table, and bed manufactured from oil palm wood

4 Conclusions

The migration of the youth to the cities to search for jobs which do not exist could be controlled if a skill development programme is developed in the field of wood processing. This paper has addressed a skill development programme for the youth. It highlights on the conversion of discarded oil palm trunk into lumber.

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